

VU Research Portal

Household and food shopping environments: do they play a role in socioeconomic inequalities in fruit and vegetable consumption? A multilevel study among Dutch adults

Giskes, K.; Lenthe, F.J.; Kamphuis, C.B.M.; Huisman, M.; Brug, J.; Mackenbach, J.P.

published in

Journal of Epidemiology and Community Health
2009

DOI (link to publisher)

[10.1136/jech.2008.078352](https://doi.org/10.1136/jech.2008.078352)

document version

Publisher's PDF, also known as Version of record

[Link to publication in VU Research Portal](#)

citation for published version (APA)

Giskes, K., Lenthe, F. J., Kamphuis, C. B. M., Huisman, M., Brug, J., & Mackenbach, J. P. (2009). Household and food shopping environments: do they play a role in socioeconomic inequalities in fruit and vegetable consumption? A multilevel study among Dutch adults. *Journal of Epidemiology and Community Health*, 63(2), 113-120. <https://doi.org/10.1136/jech.2008.078352>

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal ?

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

E-mail address:

vuresearchportal.ub@vu.nl

Household and food shopping environments: do they play a role in socioeconomic inequalities in fruit and vegetable consumption? A multilevel study among Dutch adults

K Giskes,^{1,2} F J van Lenthe,¹ C B M Kamphuis,¹ M Huisman,^{1,3} J Brug,^{1,4}
J P Mackenbach¹

¹ Department of Public Health, Erasmus Medical Centre, Rotterdam, the Netherlands;

² School of Public Health/Centre for Health and Biomedical Innovation, Queensland University of Technology, Brisbane, Australia;

³ Interdisciplinary Center for Psychiatric Epidemiology, University Medical Center Groningen, Groningen, The Netherlands; ⁴ EMGO Institute, VU Medical Centre, Amsterdam, the Netherlands

Correspondence to:
Dr K Giskes, Queensland University of Technology, C/- School of Public Health, Victoria Park Rd, Kelvin Grove, QLD, 4059, Brisbane, Australia; k.giskes@qut.edu.au

Accepted 25 August 2008

ABSTRACT

Background: Fruit and vegetables are protective of a number of chronic diseases; however, their intakes have been shown to vary by socioeconomic position (SEP). Household and food shopping environmental factors are thought to contribute to these differences. To determine whether household and food shopping environmental factors are associated with fruit and vegetable (FV) intakes, and contribute to socioeconomic inequalities in FV consumption.

Methods: Cross-sectional data were obtained by a postal questionnaire among 4333 adults (23–85 years) living in 168 neighbourhoods in the south-eastern Netherlands. Participants agreed/disagreed with a number of statements about the characteristics of their household and food shopping environments, including access, prices and quality. Education was used to characterise socioeconomic position (SEP). Main outcome measures were whether or not participants consumed fruit or vegetables on a daily basis. Multilevel logistic regression models examined between-area variance in FV consumption and associations between characteristics of the household and food shopping environments and FV consumption.

Results: Only a few household and food shopping environmental factors were significantly associated with fruit and vegetable consumption, and their prevalence was low. Participants who perceived FV to be expensive were more likely to consume them. There were significant socioeconomic inequalities in fruit and vegetable consumption (ORs of not consuming fruit and vegetables were 4.26 and 5.47 among the lowest-educated groups for fruit and vegetables, respectively); however, these were not explained by any household or food shopping environmental factors.

Conclusions: Improving access to FV in the household and food shopping environments will only make a small contribution to improving population consumption levels, and may only have a limited effect in reducing socioeconomic inequalities in their consumption.

Dietary behaviours have been established as risk factors for a number of chronic diseases. In Western countries, the most prevalent of these diseases are cardiovascular diseases and cancer.^{1,2} Population-based nutrition messages, such as dietary guidelines, have focused on improving intakes of total fat, saturated fat and antioxidant vitamins to decrease the incidence of these diseases. These guidelines almost universally encourage increased consumption of fruits and vegetables (FV).^{2–4}

However, research has shown that a large proportion of the population does not meet the dietary recommendations for FV consumption.^{2–5} Consumption of FV has been shown to be particularly low among socioeconomically disadvantaged groups.^{6–8}

A number of factors have been thought to contribute to low FV consumption among the population. These can be broadly classified as operating at the individual or environmental levels. Individual-level factors are those that operate *internal* to the individual and include knowledge, beliefs, attitudes and cognitive factors related to FV consumption. Nutrition knowledge and beliefs about their health benefits have been associated with higher consumptions of FV.^{9,10} Greater self-efficacy, motivation and perceived norms for FV consumption have also been associated with higher consumptions of FV.^{9,11} Taken together, individual-level factors only account for 20–35% of the variance in FV consumption.¹² Therefore, efforts to bring about change in these factors have only shown limited effects.

Over the past decade there has been an increased movement towards a more ecological approach to understanding health-related behaviours.¹³ This has partly resulted from studies showing significant between-area differences in a range of health-related behaviours, thereby implicating that environmental factors play an important role in shaping people's health-related behaviour.¹⁴ Social ecological theory posits that people interact with their environment, and that characteristics of these environments (such as access and availability) influence their health behaviours^{15,16} and may constrain their ability to bring about change.¹⁷ The recent increased popularity of the social ecological approach has resulted in an upsurge in the number of studies examining the role of factors *outside* individuals, such as characteristics of household and residential environments, and their influence on health-related behaviours.^{18,19}

Discussion in the literature suggests that household and food shopping environments play an important role in FV consumption.²⁰ Specifically, availability of fruit and vegetables in the household, the FV consumption of other household members as well as access to shops selling FV and the selection, quality and price of FV in these shops have been suggested to play an important role.^{21–24} However, two recent systematic reviews

examining the empirical evidence for environmental factors associated with energy, fat and FV intakes concluded that there is little evidence to support these assertions.^{25–26} A major limitation of previous research is that there have been few replicated studies examining FV consumption as outcomes, and the contributions of the household and food shopping environments specific to FV intakes. Furthermore, the contributions of these factors to socioeconomic inequalities in FV intakes have remained largely unquantified.^{27–28} Environmental interventions, and policies targeted at changing the characteristics of environments are now being promoted as promising strategies to improve health behaviour among the population.^{19–29} Owing to the limited evidence base, it is currently not known which elements of the household and food shopping environments need to be targeted in order to improve population intakes of FV and to decrease socioeconomic inequalities in their intakes.

The current study addresses this knowledge gap. Specifically, it aims to determine whether household and food shopping environmental factors are associated with FV intakes, and whether these factors contribute to socioeconomic inequalities in FV consumption.

METHODS

Participants

Data for this cross-sectional study were obtained by postal survey from the latest wave of the longitudinal GLOBE study (October 2004). The GLOBE study is a Dutch study examining the determinants of socioeconomic inequalities in health, and comprises a stratified population-based sample from the south-eastern region of the Netherlands. Detailed information about the objectives, design and findings of the GLOBE study are available elsewhere.³⁰

Participants in this wave of the GLOBE study ($n = 6377$, response rate 64.4%) consisted of two subsamples. One of these ($n = 4323$, response rate 74.4%) comprised participants that responded to the baseline questionnaire of the GLOBE study (undertaken in 1991). Attrition from the baseline postal survey was due to death (12.3%), emigration (2.0%), refusal to be followed up longitudinally (2.2%) and addresses that could not be traced (2.8%). Owing to these factors, the subsample was no longer representative of the population. Therefore, a second subsample comprising new participants ($n = 2054$, 55.0% response rate) was added to restore the population representativeness of the GLOBE study sample.

Fruit and vegetable intakes

FV intakes were measured by a food frequency questionnaire (FFQ) that has been shown to have good reliability and ability to discriminate differences in mean intakes between groups among the Dutch population.³¹ The FFQ had nine questions relating to intakes of different fruit/vegetables consumed most frequently by the Dutch population (ie, salad, fruit/vegetable juice, mandarins, other citrus, apples and pears, bananas, apple sauce, cooked vegetables and a category of “other” fruit) and had a reference period of 1 month. Potatoes were not included in the FFQ as they are not considered a vegetable in the Dutch dietary recommendations.³¹ In items with open-ended responses, participants were asked how many times they consumed each item on a weekly or monthly basis. Subsequent questions asked participants to indicate how many portions they ate on a typical occasion (eg, how many pieces, serving spoons, glasses). Intakes of each item were calculated by multiplying consumption frequency and portion size. Intakes

were summed across the various items to obtain total fruit and vegetable intakes. Intakes of both fruit and vegetables were highly skewed to the right and could not be made more normally distributed by transformation; therefore, they were dichotomised to identify participants most in need of intervention for fruit and vegetable intakes; ie, those consuming no fruit or vegetables (ie, 0 g) on either a daily/weekly or monthly basis.

Food environment

Prior to developing the postal questionnaire, we conducted focus groups and a systematic review of the literature to identify the most salient environmental factors in relation to fruit and vegetable consumption. The focus groups comprised GLOBE study participants from different socioeconomic backgrounds. During the focus groups, participants were asked about their main barriers and facilitators to consuming fruit and vegetables.²⁵ Those factors mentioned with the most frequency, the greatest intensity and that were talked about differentially among socioeconomic groups were selected for inclusion in the postal questionnaire. We also conducted a systematic literature review summarising the evidence pertaining to environmental factors associated with fruit and vegetable intakes among adults and selected the most important factors identified in the literature.^{8–25} Using these methods, seven salient environmental factors were identified in relation to fruit consumption and eight factors regarding vegetable consumption. On the postal questionnaire participants were presented with a series of statements relating to each factor (eg, “fruit is expensive”) and were provided the response categories “agree” and “disagree”. Also, participants indicated the frequency with which these factors were actual barriers for their FV consumption (often, sometimes, seldom/never). Responses to these statements were missing for approximately 5% of the sample. Missing values were imputed by drawing randomly from the binomial distribution using observed prevalences per education class as probabilities.

Socioeconomic position

Participants were asked about their highest attained level of education. From the eight response categories, four categories were constructed: elementary (8 or less years), lower secondary (9–11 years), higher secondary (12–13 years) and tertiary (14 or more years). We also measured household income, asking participants to report their net monthly household income (€0–1200, €1200–1800, €1800–2600, €2600 or more, and “don’t want to say/ don’t know”).

Statistical analyses

Participants that had moved out of the study region ($n = 1528$) were excluded from the analyses. Those with missing values for education or fruit/vegetable consumption ($n = 277$) were excluded, as well as participants with missing values for one or more of the confounding variables, ie, age, sex ($n = 93$). Furthermore, we excluded participants residing in neighbourhoods with fewer than three participants ($n = 146$). Therefore, the analytic sample comprised 4333 participants who resided in 168 neighbourhoods (mean number of participants per neighbourhood = 26, range 4–112).

To take into account clustering in the environmental factors between neighbourhoods, multilevel models consisting of participants (level 1) nested in neighbourhoods (level 2) were used in all analyses. The analyses for this study comprised two phases: a descriptive phase and a multivariable modelling phase.

In the descriptive phase, associations between SEP, the food environments and fruit/vegetable consumption were examined by cross-tabulations.

In the multivariable modelling phase, logistic regression models (using the link logit function and second-order penalised quasi-likelihood estimation methods³²) examined the associations of (groups of) household/food shopping environmental factors with FV consumption. Subsequent analyses examined education differences in FV consumption. Household and food shopping environment factors were then entered (separately and then simultaneously) in order to investigate their contribution to the education inequalities. The factors of interest in these analyses were the direction and significance of the fixed effects for the household/food shopping environment factors, and the attenuation of the magnitude of inequalities when groups of factors were added. Clustering of FV consumption within neighbourhoods was determined by calculating the median odds ratio (MOR) with 95% credible intervals (CRIs), using the posterior distribution of the area variance as provided by the Markov Chain Monte Carlo procedure. The MOR was calculated using the following formula:³³

$$\text{MOR} = \exp \sqrt{(2 \times \text{area variance}) \times 0.6745}$$

$$\approx \exp(0.95 \times \sqrt{\text{area variance}})$$

All analyses were weighted to take into account the oversampling of older participants, and oversampling of participants with chronic diseases in the sample (relative to the population of the region in which the study took place). Oversampled participants received a weighting of <1, and undersampled participants were weighted >1, with the total sample size of the weighted analyses being equal to the number of participants ($n = 4333$). Additionally, all analyses were adjusted for gender and age (continuous) and were conducted in MLwiN version 2.³⁴

RESULTS

The mean age of the sample was 48.0 years (SD 13.3 years) and 54.1% were women. Of respondents 86.5% and 85.1% consumed fruit and vegetables on a daily basis (respectively). Table 1 summarises the associations between environmental factors and fruit consumption, and education differences in the perceptions of environmental factors. Participants who reported there was not much fruit in their household, that there were no shops where they could buy fruit in their neighbourhood or had difficulty getting to shops that sold fruit were less likely to consume fruit. However, those who perceived fruit as expensive were more likely to consume it.

Overall, a large proportion of participants (52.5%) perceived that fruit was expensive and this perception was more frequent among lower socioeconomic groups. Only a small proportion (10–15%) reported household factors as being important. There were small education gradients in household factors being reported as important, with lower educated groups agreeing with the statements more frequently. Few participants (<10%) agreed with other statements relating to the food shopping environment; however, there were small education gradients for some factors that reached statistical significance.

Associations between environmental factors and vegetable consumption, and education differences in the perceptions of environmental factors in relation to vegetable consumption are

shown in Table 2. Living in a household where the cook did not prepare many vegetables was strongly associated with not consuming vegetables. Likewise, having no shops in the neighbourhood where vegetables could be purchased or having difficulty getting to shops that sold them was associated with not consuming them.

The majority of participants (55.9%) agreed that vegetables were expensive. However, only a small proportion agreed with other statements relating to household or shopping environmental factors. There were inverse education gradients in participants reporting there were no shops where they could buy vegetables, that vegetables were expensive, that the selection of them was limited where they shopped, and that it is difficult for them to get to shops that sold vegetables. The magnitude of these gradients were small; however, the large sample size resulted in them reaching statistical significance.

The contribution of the household and food shopping environmental factors to fruit consumption is shown in Table 3. The base model showed direct and graded associations between education and fruit consumption; participants with lower education were more likely to not consume fruit daily. Subsequent models in this table show that the addition of household and food shopping environmental factors (in separate and combined models) did not make a contribution to explaining socioeconomic differences in fruit consumption. Three environmental factors were significantly associated with fruit consumption in the fully adjusted model; having no fruit at home and living in a neighbourhood where there were no shops to purchase fruit were associated with no consumption. However, participants who perceived fruit as expensive were more likely to consume it.

Table 4 summarises the contributions of household and food shopping environmental factors to vegetable consumption. The baseline model confirmed a marked socioeconomic gradient in vegetable consumption. However, the environmental factors examined did not contribute to explaining these inequalities in vegetable consumption. Living in a household where vegetables are not prepared and residing in a neighbourhood where there are no shops in which vegetables can be purchased were associated with a reduced likelihood of vegetable consumption. Having the perception that vegetables are expensive was independently associated with their consumption.

All analyses were also performed using household income as the SEP measure. The direction and magnitude of the income inequalities were similar to those reported for education. The role of household and food shopping environmental factors remained the same with household income. The addition of household income into the multivariate models did not decrease socioeconomic differences in FV consumption.

DISCUSSION

Our study showed that perceptions of some household and food shopping environmental factors were related to FV consumption. However, due to their general low prevalence and small inequalities, they did not play a role in socioeconomic inequalities in their consumption. These findings suggest that interventions aimed at improving access to FV in the household and/or food shopping environments may only make a small contribution to improving population consumption levels. Moreover, the selected household and environmental characteristics may not decrease socioeconomic inequalities in their consumption.

The findings of this study must be interpreted in the context of a number of study limitations. The cross-sectional nature of

Table 1 Age- and gender-adjusted associations between household/food shopping environments, fruit consumption and education

	OR of no fruit consumption	Proportion of respondents by education level				
	OR* (95% CI)	1 (low)	2	3	4 (high)	p Value†
<i>Household environment</i>						
There is not much fruit in my household						
Agree	1.86 (1.33 to 2.59)	11.3	5.8	8.3	8.6	<0.01
Disagree	1.00	88.7	94.2	91.7	91.4	
My family do not eat much fruit						
Agree	1.17 (0.87 to 1.57)	15.7	15.7	17.0	12.9	0.03
Disagree	1.00	84.3	84.3	83.0	87.1	
<i>Food shopping environment</i>						
In my neighbourhood there are no shops where I can buy fruit						
Agree	1.60 (1.06 to 2.41)	3.0	4.1	3.1	3.8	0.52
Disagree	1.00	97.0	95.9	96.9	96.2	
Fruit is expensive						
Agree	0.79 (0.62 to 1.00)	53.9	53.6	44.5	41.0	<0.01
Disagree	1.00	46.1	46.4	55.5	59.0	
The selection of fruit is limited						
Agree	1.45 (0.87 to 2.41)	7.5	3.0	2.6	3.5	<0.01
Disagree	1.00	92.5	97.0	97.4	96.5	
It is difficult to get to shops that sell fruit						
Agree	2.12 (1.07 to 4.20)	2.2	1.1	0.7	1.0	0.09
Disagree	1.00	97.8	98.9	99.3	99.0	
The fruit is of bad quality						
Agree	1.12 (0.61 to 2.05)	3.0	2.0	2.8	3.5	0.11
Disagree	1.00	97.0	98.0	97.2	96.5	

*Analyses adjusted for gender, age.

†Denotes p value for education differences in prevalence of responses.

the current study does not allow us to ascertain causal relationships between household and food shopping environmental factors and socioeconomic inequalities in FV consumption. The findings of the study can only be generalised to the study region. All regions (including the one in which this study was undertaken) have unique demographic/socioeconomic characteristics and a spatial patterning of food retail environments, in addition to the FV intakes of residents.³⁵ Furthermore, measurement artefact may contribute to biased associations between SEP and FV consumption. All dietary assessment instruments employed in population-based research (including the one used in this study) rely on participant's abilities to accurately recall, describe and quantify their intakes.³⁶ These skills are socioeconomically patterned, and are likely to be less developed among disadvantaged groups, therefore our estimates of socioeconomic inequalities in FV consumption may be somewhat attenuated.

Similar to other studies^{2 6 7} we found strong socioeconomic gradients in FV consumption. The finding that the food shopping environment only made a small contribution to FV consumption, and did not contribute to socioeconomic inequalities in FV consumption was in line with the emerging literature. Research from the UK³⁷ and Australia^{10 38} suggests that the food shopping environment may not play an important role in food purchasing decisions, or for explaining socioeconomic variation in food choice and FV purchasing. In contrast, findings from the USA suggest that the food shopping environment in socioeconomically deprived areas is less

Table 2 Age- and gender-adjusted associations between household/food shopping environments, vegetable consumption and education

	OR of no vegetable consumption	Proportion of respondents by education level					
	OR* (95% CI)	1 (low)	2	3	4 (high)	p Value†	
<i>Household environment</i>							
There are not many vegetables in my household							
Agree	1.21 (0.85 to 1.72)	9.4	6.4	8.3	9.5	0.02	
Disagree	1.00	90.6	93.6	91.7	90.5		
My family do not eat many vegetables							
Agree	1.07 (0.77 to 1.50)	7.7	9.3	10.4	8.0	0.14	
Disagree	1.00	92.3	90.7	89.6	92.0		
The person who cooks in my household does not cook many vegetables							
Agree	3.03 (1.90 to 4.86)	2.8	2.1	2.8	2.7	0.65	
Disagree	1.00	97.2	97.9	97.2	97.3		
<i>Food shopping environment</i>							
In my neighbourhood there are no shops where I can buy vegetables							
Agree	1.67 (1.13 to 2.46)	8.3	5.6	3.8	4.5	<0.01	
Disagree	1.00	91.7	94.4	96.2	95.5		
Vegetables are expensive							
Agree	0.79 (0.63 to 0.98)	53.3	49.1	41.2	37.3	<0.01	
Disagree	1.00	46.7	50.9	58.8	62.7		
The selection of vegetables is limited							
Agree	1.45 (0.98 to 2.14)	7.5	4.7	4.3	5.6	0.07	
Disagree	1.00	92.5	95.3	95.7	94.4		
It is difficult to get to shops that sell vegetables							
Agree	1.37 (1.12 to 3.92)	3.3	1.5	1.1	1.0	<0.01	
Disagree	1.00	96.7	98.5	98.9	99.0		
The vegetables are of bad quality							
Agree	1.27 (0.69 to 2.33)	3.9	2.5	3.5	3.7	0.30	
Disagree	1.00	96.1	97.5	96.5	96.3		

*Analyses adjusted for gender, age.

†Denotes p value for education differences in prevalence of responses.

conducive to making healthy food choices than in more advantaged areas.³⁹ However, the Dutch situation may differ from the USA in many ways that affect the food shopping environment. The Dutch population is less stratified along socioeconomic lines, is less geographically segregated by SEP, and the population density in the Netherlands is greater than the in USA^{37 40} and (consequently) shops are always nearby. A recent Australian study found that a significant proportion of socioeconomic inequalities in FV consumption were explained by perceived availability, accessibility and affordability factors. However, this study was only conducted among women and measured general perceptions of the food environment, rather than perceptions of the food environment specific to FV.⁴¹ Previous research that has examined socioeconomic differences in perceptions of barriers to consuming a health diet has shown that these are greater when perceptions about diet in general are measured, rather than when perceptions are assessed relative to a specific food group.

The finding that perceptions of the food shopping environment explained little of the socioeconomic variation in FV consumption is also in accordance with objective measures of the food shopping environment. Environmental audits of food shopping environments with respect to FV purchasing were

Table 3 Contribution of the household and food shopping environments to education and between-area inequalities in consumption of no fruit*

		OR of no fruit consumption (95% CI)		
	Base model	Base model+household environment	Base model+shopping environment	Base model+all predictors
<i>Education level</i>				
1 (low)	4.26 (3.00 to 6.07)	4.14 (2.91 to 5.89)	4.44 (3.18 to 6.19)	4.35 (3.06 to 6.19)
% attenuation†		−2.8	+4.2	+2.1
2	2.36 (1.80 to 3.11)	2.41 (1.83 to 3.17)	2.48 (1.85 to 3.33)	2.51 (1.87 to 3.37)
% attenuation†		+2.1	+5.1	+6.4
3	1.60 (1.15 to 2.23)	1.60 (1.15 to 2.23)	1.63 (1.17 to 2.28)	1.63 (1.17 to 2.28)
% attenuation†		0	+1.9	+1.9
4 (high)	1.00	1.00	1.00	1.00
<i>Household environment</i>				
There is not much fruit in my household				
Agree		1.86 (1.31 to 2.65)		1.88 (1.29 to 2.72)
Disagree		1.00		1.00
My family do not eat much fruit				
Agree		0.94 (0.69 to 1.29)		0.95 (0.70 to 1.30)
Disagree		1.00		1.00
<i>Food shopping environment</i>				
In my neighbourhood there are no shops where I can buy fruit				
Agree			1.68 (1.09 to 2.59)	1.67 (1.08 to 2.56)
Disagree			1.00	1.00
Fruit is expensive				
Agree			0.71 (0.56 to 0.90)	0.70 (0.55 to 0.88)
Disagree			1.00	1.00
The selection of fruit is limited				
Agree			1.25 (0.69 to 2.24)	1.14 (0.62 to 2.09)
Disagree			1.00	1.00
It is difficult to get to shops that sell fruit				
Agree			1.54 (0.69 to 3.43)	1.49 (0.65 to 3.40)
Disagree			1.00	1.00
The fruit is of bad quality				
Agree			1.01 (0.49 to 2.09)	0.97 (0.46 to 2.04)
Disagree			1.00	1.00
<i>Random effects</i>				
Between area variance (SE)	0.17 (0.05)	0.16 (0.05)	0.17 (0.05)	0.16 (0.05)
MOR (95% CRI)‡	1.47 (1.18 to 1.67)	1.46 (1.16 to 1.69)	1.47 (1.17 to 1.67)	1.46 (1.16 to 1.69)

*Analyses adjusted for gender, age.

†% attenuation = [(OR model − OR base model)/OR base model] × 100

‡MOR = exp (0.95√area variance).¹

CRI, credible interval; MOR, median odds ratio.

conducted on a sub-set of 14 areas covered by the study (7 socioeconomically disadvantaged areas, 7 advantaged areas). An area of 1 km from the centroid of each area was audited. Audits assessed the price and availability of fruits and vegetables in 61 shops. Deprived areas had greater access to supermarkets compared to advantaged areas, and were equally serviced in terms of fruit and vegetable shops (Table 5). The variety, price and quality of fruits were similar in socioeconomically deprived and advantaged areas, however vegetables were marginally (~10%) cheaper (on average) in deprived areas (Table 5). These findings suggest that deprived areas were at least equally (perhaps even slightly better) serviced in terms of their food shopping infrastructure with respect to FV purchase compared

to socioeconomically advantaged areas. Similarly, an Australian study also found no differences in FV food shopping infrastructure, and the availability and price of FV in deprived and advantaged areas.³⁸

Our study is the first (known) study to quantify associations between accessibility of FV in the household and their consumption among adults. Studies among children/adolescents have found that household availability of FV, and the FV consumptions of parents are associated with their intakes.⁴² However, we found little evidence to support that the household food environment plays a role among adults. This may be because adults exert a greater influence than children/adolescents on the food available in the household, and make most food purchasing decisions.

Table 4 Contribution of the household and food shopping environments to education and between-area inequalities in consumption of no vegetables*

		Likelihood of no vegetable consumption (95% CI)		
	Base model	Base model+household environment	Base model+shopping environment	Base model+all predictors
<i>Education</i>				
1 (low)	5.47 (3.92 to 7.64)	5.47 (3.92 to 7.64)	5.64 (4.04 to 7.87)	5.64 (4.04 to 7.87)
% attenuation†		0	+3.1	+3.1
2	2.39 (1.81 to 3.14)	2.39 (1.78 to 3.20)	2.48 (1.85 to 3.33)	2.48 (1.85 to 3.33)
% attenuation†		0	+3.8	+3.8
3	1.68 (1.23 to 2.30)	1.68 (1.23 to 2.30)	1.72 (1.25 to 2.35)	1.72 (1.23 to 2.39)
% attenuation†		0	+2.4	+2.4
4 (high)	1.00	1.00	1.00	1.00
<i>Household environment</i>				
There are not many vegetables in my household				
Agree		1.02 (0.70 to 1.48)		1.03 (0.71 to 1.50)
Disagree		1.00		1.00
My family do not eat many vegetables				
Agree		0.85 (0.59 to 1.24)		0.85 (0.58 to 1.26)
Disagree		1.00		1.00
The person who cooks in my household does not cook vegetables				
Agree		3.16 (1.86 to 5.36)		2.97 (1.75 to 5.05)
Disagree		1.00		1.00
<i>Food shopping environment</i>				
In my neighbourhood there are no shops where I can buy vegetables				
Agree			1.54 (1.06 to 2.23)	1.46 (0.99 to 2.16)
Disagree			1.00	1.00
Vegetables are expensive				
Agree			0.69 (0.56 to 0.86)	0.69 (0.56 to 0.86)
Disagree			1.00	1.00
The selection of vegetables is limited				
Agree			1.34 (0.85 to 2.10)	1.34 (0.85 to 2.10)
Disagree			1.00	1.00
It is difficult to get to shops that sell vegetables				
Agree			1.43 (0.77 to 2.68)	1.30 (0.68 to 2.48)
Disagree			1.00	1.00
The vegetables are of bad quality				
Agree			1.11 (0.56 to 2.19)	1.01 (0.51 to 2.01)
Disagree			1.00	1.00
<i>Random effects</i>				
Between-area variance (SE)	0.14 (0.06)	0.13 (0.06)	0.15 (0.06)	0.14 (0.06)
MOR (95% CRI)‡	1.40 (1.10 to 1.62)	1.41 (1.09 to 1.63)	1.44 (1.13 to 1.66)	1.40 (1.11 to 1.64)

*Analyses adjusted for gender, age.

†% attenuation = [(OR model – OR base model)/OR base model] × 100

‡MOR = exp (0.95√area variance).¹

CRI, credible interval; MOR, median odds ratio.

The findings of the current study suggest that the low FV consumption among adults and socioeconomic inequalities in their consumption may have little to do with household and food shopping environments. In addition to perceptions, we also measured objective characteristics of the food environment; however, we could not quantify the contribution of these factors to socioeconomic inequalities in FV consumption as only a limited number of neighbourhoods were audited. Other environmental factors, such as cultural factors, may be more important. Culture has been known as the foundation that underlies food choices, as it determines what people consider to be acceptable and preferable foods, and the

amount and combinations of food they choose.^{43 44} However, cultural influences were not measured in this study, as they are difficult to conceptualise and no validated questionnaires concerning cultural aspects of diet are known to be available. Variations in FV consumption could also be more a consequence of individual-level factors. A number of individual-level factors have been relatively under-researched in relation to FV consumption and inequalities in these, such as taste preferences, cooking skills and habit.^{45 46} Additionally, other household-level factors that were not measured in the current study such as facilities for FV preparation and storage, and the negotiation of food purchasing decisions among

Table 5 Shop availability and price of fruits and vegetables in socioeconomically disadvantaged and advantaged areas

	Disadvantaged areas (n = 7)*	Advantaged areas (n = 7)†
Shop (total n)		
Supermarket	34	15
Fruit and vegetable shop	4	3
Specialty shop (eg, delicatessen, ethnic food store)	1	4
Average fruit prices (per kg, €)		
Apples	1.15	1.21
Oranges	1.44	1.56
Banana	1.60	1.59
Kiwi	2.15	2.16
Pear	1.44	1.57
All fruit combined	7.77	8.08
Average vegetable prices (€)		
Broccoli (1 head)	2.26	2.66
Beans (1 kg)	3.70	4.01
Cauliflower (1 head)	1.92	2.02
Carrots (1 kg)	1.20	1.68
Tomatoes (1 kg)	2.02	2.04
All vegetable combined	10.92	12.41

*All areas in the study region (n = 86) were ranked by their NIVEL (Netherlands Institute for Health Services Research) deprivation index (derived from the proportion of the population that is economically active, average income, proximity index and proportion of the population who are non-Western foreigners). Refer to¹ for further details of the deprivation index. The seven lowest and highest ranking areas were selected for audits.

household members have been implicated to play a role in other studies.^{6,46}

There is little evidence to justify that interventions aimed at improving FV consumption in the Netherlands, and at reducing socioeconomic inequalities in them should target our selected determinants of the household/food shopping environments. The current study suggests that research into other environmental factors, such as cultural aspects of dietary habits, and individual-level factors could bring forth more salient determinants of FV consumption. Changes in these potentially important factors are more likely to bring about population dietary change and reducing inequalities in FV consumption than making changes to the household and/or food shopping environments.

What this study adds

- There has been an increased movement toward a more ecological approach to understanding health-related behaviours. The current study examined whether household and food shopping environmental factors are associated with fruit and vegetable intakes, and whether these factors contribute to socioeconomic inequalities in fruit and vegetable consumption.
- Household and food shopping environmental factors only made a small contribution to explaining fruit and vegetable consumption; however, they did not play a role in socioeconomic inequalities in fruit and vegetable consumption.
- Interventions aimed at improving our selected household and food shopping environmental factors may have a limited contribution to improving population consumption levels; however, may not decrease socioeconomic inequalities in their consumption.

Competing interests: None declared.

Ethics approval: Ethics approval was obtained.

REFERENCES

1. Lawlor DA, Sterne JA, Tynelius P, *et al.* Association of childhood socioeconomic position with cause-specific mortality in a prospective record linkage study of 1,839,384 individuals. *Am J Epidemiol* 2006;**164**:907–15.
2. Krebs-Smith SM, Kantor LS. Choose a variety of fruits and vegetables daily: understanding the complexities. *J Nutr* 2001;**131**:487S–501S.
3. Voedingscentrum. Regels schijf van vijf (Dutch dietary guidelines) (<http://www.voedingscentrum.nl/AcitesEnAchtergronden/Schijf+van+Vijf/>). Den Haag: Voedingscentrum, 2007.
4. Australian National Health and Medical Research Council. *Dietary guidelines for Australians*. Canberra: Australian Government Publishing Service, 1992.
5. Kearney JM, McElhone S. Perceived barriers in trying to eat healthier—results of a pan-EU consumer attitudinal survey. *Br J Nutr* 1999;**81**(Suppl 2):S133–7.
6. Giskes K, Turrell G, Patterson C, *et al.* Socio-economic differences in fruit and vegetable consumption among Australian adolescents and adults. *Public Health Nutr* 2002;**5**:663–9.
7. Hulshof KF, Brussaard JH, Kruijzinga AG, *et al.* Socio-economic status, dietary intake and 10 y trends: the Dutch National Food Consumption Survey. *Eur J Clin Nutr* 2003;**57**:128–37.
8. Kamphuis CB, Giskes K, de Bruijn GJ, *et al.* Environmental determinants of fruit and vegetable consumption among adults: a systematic review. *Br J Nutr* 2006;**96**:620–35.
9. Steptoe A, Perkins-Porras L, Rink E, *et al.* Psychological and social predictors of changes in fruit and vegetable consumption over 12 months following behavioral and nutrition education counseling. *Health Psychol* 2004;**23**:574–81.
10. Ball K, Crawford D, Mishra G. Socio-economic inequalities in women's fruit and vegetable intakes: a multilevel study of individual, social and environmental mediators. *Public Health Nutr* 2006;**9**:623–30.
11. Trudeau E, Kristal AR, Li S, *et al.* Demographic and psychosocial predictors of fruit and vegetable intakes differ: implications for dietary interventions. *J Am Diet Assoc* 1998;**98**:1412–7.
12. Bogers RP, Brug J, van Assema P, *et al.* Explaining fruit and vegetable consumption: the theory of planned behaviour and misconception of personal intake levels. *Appetite* 2004;**42**:157–66.
13. Glanz K, Rimer B, Lewis F. *Health behaviour and health education*. San Francisco: Jossey-Bass, 2002.
14. Vereecken CA, Inchley J, Subramanian SV, *et al.* The relative influence of individual and contextual socio-economic status on consumption of fruit and soft drinks among adolescents in Europe. *Eur J Public Health* 2005;**15**:224–32.
15. Powell LM, Slater S, Mirtcheva D, *et al.* Food store availability and neighborhood characteristics in the United States. *Prev Med* 2007;**44**:189–95.
16. Beydoun MA, Powell LM, Wang Y. The association of fast food, fruit and vegetable prices with dietary intakes among US adults: is there modification by family income? *Soc Sci Med* 2008;**66**:2218–29.
17. Giles-Corti B. People or places: what should be the target? *J Sci Med Sport* 2006;**9**:357–66.
18. Humpel N, Owen N, Leslie E. Environmental factors associated with adults' participation in physical activity: a review. *Am J Prev Med* 2002;**22**:188–99.
19. Booth SL, Sallis JF, Ritenbaugh C, *et al.* Environmental and societal factors affect food choice and physical activity: rationale, influences, and leverage points. *Nutr Rev* 2001;**59**:S21–39; discussion S57–65.
20. Gittelsohn J, Anliker JA, Sharma S, *et al.* Psychosocial determinants of food purchasing and preparation in American Indian households. *J Nutr Educ Behav* 2006;**38**:163–8.
21. Drewnowski A. Obesity and the food environment: dietary energy density and diet costs. *Am J Prev Med* 2004;**27**:154–62.
22. Stevenson C, Doherty G, Barnett J, *et al.* Adolescents' views of food and eating: identifying barriers to healthy eating. *J Adolesc* 2007;**30**:417–34.
23. Kearney M, Kearney J, Dunne A, *et al.* Sociodemographic determinants of perceived influences on food choice in a nationally representative sample of Irish adults. *Public Health Nutr* 2000;**3**:219–26.
24. Inglis V, Ball K, Crawford D. Why do women of low socioeconomic status have poorer dietary behaviours than women of higher socioeconomic status? A qualitative exploration. *Appetite* 2005;**45**:334–43.
25. Kamphuis CB, van Lenthe FJ, Giskes K, *et al.* Perceived environmental determinants of physical activity and fruit and vegetable consumption among high and low socioeconomic groups in the Netherlands. *Health Place* 2007;**13**:493–503.
26. Giskes K, Kamphuis CB, van Lenthe FJ, *et al.* A systematic review of associations between environmental factors, energy and fat intakes among adults: is there evidence for environments that encourage obesogenic dietary intakes? *Public Health Nutr* 2007;**1**:1–13.
27. Turrell G, Kavanagh A. Socioeconomic pathways to diet: modelling the association between socioeconomic position and food purchasing behaviour. *Public Health Nutr* 2006;**9**:375–383.
28. Beydoun MA, Wang Y. How do socio-economic status, perceived economic barriers and nutritional benefits affect quality of dietary intake among US adults? *Eur J Clin Nutr* 2008;**62**:303–13.
29. Stokols D, Grzywacz JG, McMahan S, *et al.* Increasing the health promotive capacity of human environments. *Am J Health Promot* 2003;**18**:4–13.

30. **van Lenthe FJ**, Schrijvers CT, Droomers M, *et al.* Investigating explanations of socio-economic inequalities in health: the Dutch GLOBE study. *Eur J Public Health* 2004;**14**:63–70.
31. **Van Assema P**, Brug J, Ronda G, *et al.* A short Dutch questionnaire to measure fruit and vegetable intake: relative validity among adults and adolescents. *Nutr Health* 2002;**16**:85–106.
32. **Rasbash J**, Steele F, Browne W, *et al.* A user's guide to MLwiN. Bristol: Centre for Multilevel Modelling, University of Bristol, 2005.
33. **Merlo J**, Chaix B, Ohlsson H, *et al.* A brief conceptual tutorial of multilevel analysis in social epidemiology: using measures of clustering in multilevel logistic regression to investigate contextual phenomena. *J Epidemiol Community Health* 2006;**60**:290–7.
34. **Rasbash J**, Browne W, Healy M, *et al.* MLwiN version 1.10.0007. 2001.
35. **Cummins S**, MacIntyre S. A systematic study of an urban foodscape: the price and availability of food in greater Glasgow. *Urban Stud* 2002;**39**:2115–30.
36. **Gibson R**. Measurement errors in dietary assessment. In: Gibson R, ed. *Principles of nutritional assessment*. Oxford: Oxford University Press, 1990.
37. **Cummins S**, Macintyre S. Food environments and obesity--neighbourhood or nation? *Int J Epidemiol* 2006;**35**:100–4.
38. **Winkler E**, Turrell G, Patterson C. Does living in a disadvantaged area mean fewer opportunities to purchase fresh fruit and vegetables in the area? Findings from the Brisbane food study. *Health Place* 2006;**12**:306–19.
39. **Morland K**, Wing S, Diez Roux A. The contextual effect of the local food environment on residents' diets: the atherosclerosis risk in communities study. *Am J Public Health* 2002;**92**:1761–7.
40. **Giskes K**, Turrell G, van Lenthe FJ, *et al.* A multilevel study of socio-economic inequalities in food choice behaviour and dietary intake among the Dutch population: the GLOBE study. *Public Health Nutr* 2006;**9**:75–83.
41. **Inglis V**, Ball K, Crawford D. Socioeconomic variations in women's diets: what is the role of perceptions of the local food environment? *J Epidemiol Community Health* 2008;**62**:191–7.
42. **De Bourdeaudhuij I**, Te Velde S, Brug J, *et al.* Personal, social and environmental predictors of daily fruit and vegetable intake in 11-year-old children in nine European countries. *Eur J Clin Nutr* 2007.
43. **Lennernas M**, Fjellstrom C, Becker W, *et al.* Influences on food choice perceived to be important by nationally-representative samples of adults in the European Union. *Eur J Clin Nutr* 1997;**51**(Suppl 2):S8–15.
44. **Sorensen G**, Stoddard AM, Dubowitz T, *et al.* The influence of social context on changes in fruit and vegetable consumption: results of the healthy directions studies. *Am J Public Health* 2007;**97**:1216–27.
45. **Larson NI**, Perry CL, Story M, *et al.* Food preparation by young adults is associated with better diet quality. *J Am Diet Assoc* 2006;**106**:2001–7.
46. **Murcott A**. Nutrition and inequalities. A note on sociological approaches. *Eur J Public Health* 2002;**12**:203–7.